

Nucleonica Data Centre:

Nuclide Explorer

DataSheets

Nuclear Data Retrieval

Fission Yields

Universal Nuclide Chart

Karlsruhe Nuclide Chart

The screenshot shows the Nucleonica web application interface. At the top, there is a navigation bar with links for Applications, My Preferences, and Help. The main header features the Nucleonica logo and the tagline "... web driven nuclear science". Below the header, the interface is divided into several sections:

- Nuclide Explorer:** Displays a plot of the Karlsruhe Nuclide Chart, showing various nuclides and their decay paths. Below the plot, it says "» Actual Chart: Karlsruhe".
- Search Nucleonica Documentation:** A search bar with a "Search" button.
- Nuclear Data Retrieval:** A section for retrieving nuclear data.
- Application Centre:** A list of applications including:
 - Mass Activity Calculator
 - Decay Engine
 - Dosimetry & Shielding
 - Range & Stopping Power
 - webKORIGEN
 - Universal Nuclide Chart
 - Transport & Packaging
 - Nuclide mixtures
 - Nucleonica Scripting
 - Library creation for 3rd party software
 - Radiological Dispersion Module
 - Gamma Spectrum Generator (IE only)
 - easy Monte Carlo (IE only)
 - Cambio file Converter
 - Extended Graph Module
- Data Centre:** A list of data resources including:
 - Physical Constants
 - Nuclide Reference Data
 - Nuclide Derived Data
 - Average Cross Sections
 - Radiations
 - Prompt Gamma
 - Fission Yields
- Personalized User Area:** On the right, a sidebar for a user named Joe, including:
 - Welcome, Joe
 - Links to Edit Preferences, Administration, and MyCommunity Portal
 - My Last Nuclides: A list of nuclides like 91 Pa230, 91 Pa231, 94 Pu239, 56 Ba133, and 77 Ir192.
 - My Nuclide Mixtures: A list of mixtures like Natural Uranium, Depleted Uranium (0.4%U235), Ba-Pu, U232(0.4g)+Co60(0.6g), and U232+Co60.
 - My Sources: A list of sources like name3_srce.xml and Pu239 1 g.
 - My Messages: A section for messages.
 - User Alerts: A section for alerts.

This is a blurred version of the screenshot above, showing the same Nucleonica web application interface with various sections like Nuclide Explorer, Application Centre, and Data Centre.

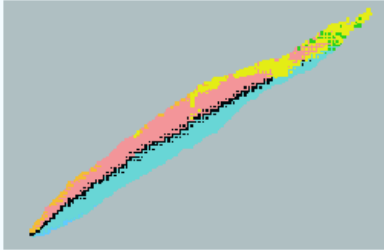
Where do we find nuclear data in Nucleonica?

Logged in as: magill Networking Nuclear Science Search Forum Calculator Privacy Legal

nucleonica ... web driven nuclear science

Applications My Preferences Help

► **Nuclide Explorer**



» Actual Chart: Karlsruhe

► **Search Nucleonica Documentation**

► **Application Centre**

- » Mass Activity Calculator
- » Decay Engine
- » Dosimetry & Shielding
- » Range & Stopping Power
- » webKORIGEN
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- » **Nuclide mixtures**
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► **Data Centre**

- » Physical Constants
- » Nuclide Reference Data
- » Nuclide Derived Data
- » Average Cross Sections
- » Radiations
- » Prompt Gamma
- » Fission Yields

Nuclear Data Retrieval

nucleonica [wiki]

Welcome, Joe

[Edit Preferences](#) [Administration](#)
[MyCommunity Portal](#)

► **My Last Nuclides**

- ☒ 91 Pa230
- ☒ 91 Pa231
- ☒ 94 Pu239
- ☒ 56 Ba133
- ☒ 77 Ir192

► **My Nuclide Mixtures**

- 📖 Natural Uranium
- 📖 Depleted Uranium (0.4%U235)
- 📖 Ba-Pu
- 📖 U232(0.4g)+Co60(0.6g)
- 📖 U232+Co60

► **My Sources**

- 📖 name3_srce.xml
- 📖 Pu239 1 g

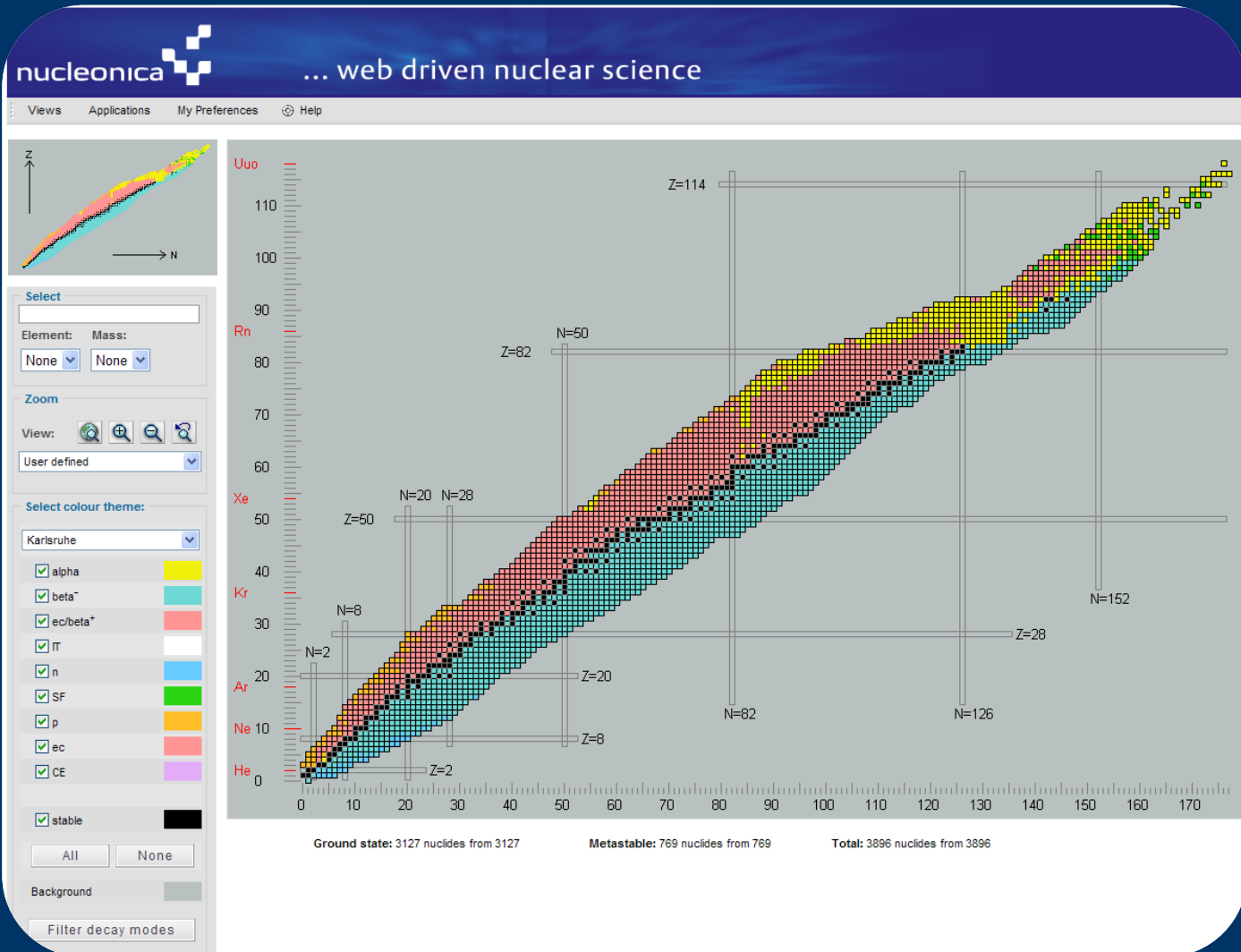
► **My Messages**

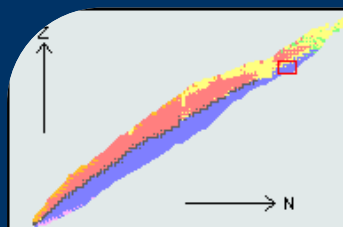
No messages for you at the moment

► **User Alerts**

No alerts at the moment

Nuclide Explorer...





Select

90 Thorium 232

Element: Mass:

Th

232

Zoom

View:



5

Select colour theme:

Standard

☒ alpha

☒ beta -

☒ beta+

☒ IT

☒ n

☒ SF

☒ p

☒ ec



Highlight daughters

Show decay chain

Reference Data

Element Information

Decay Engine

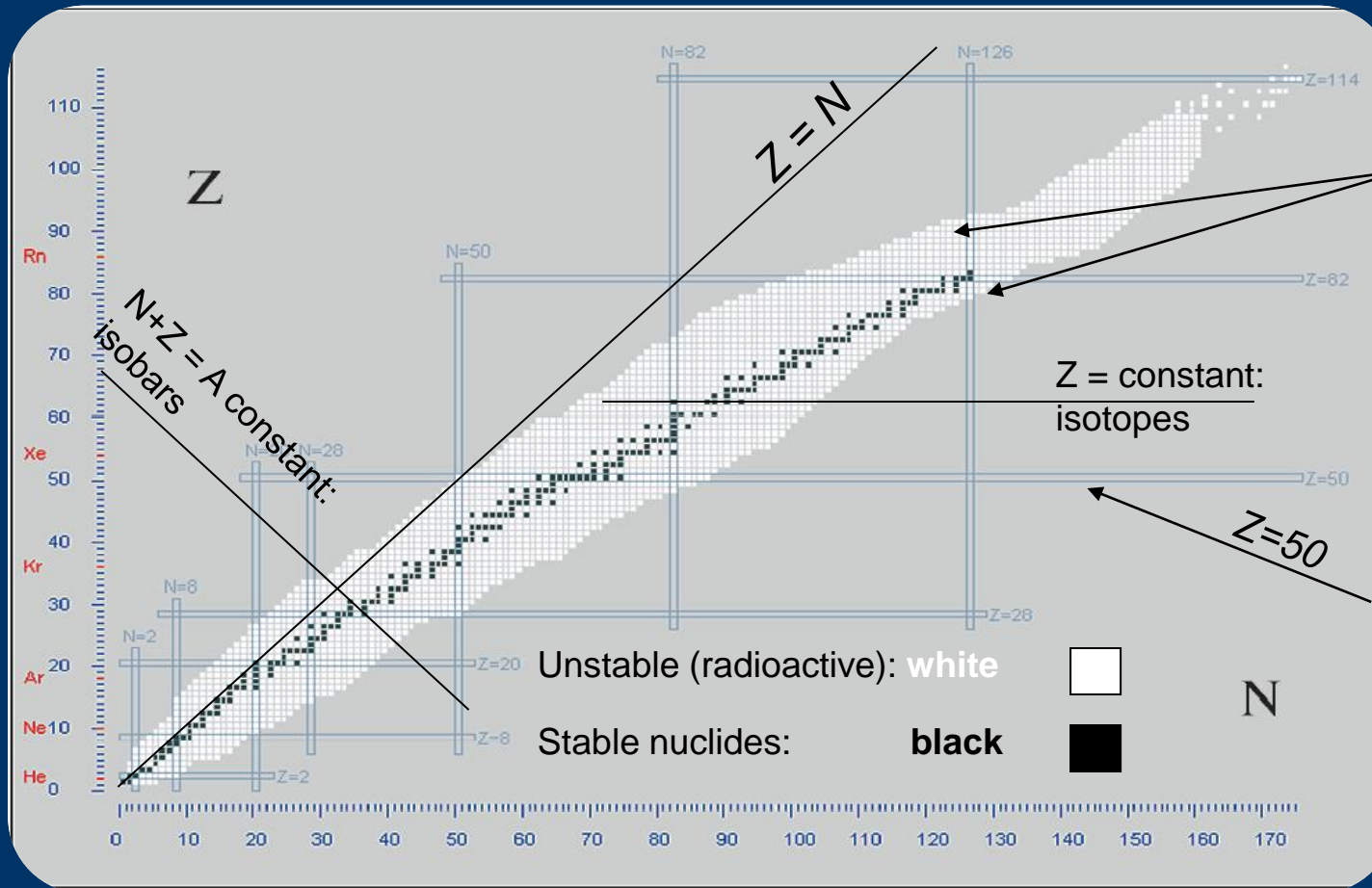
Dosimetry & Shielding

Get image

Remove red border

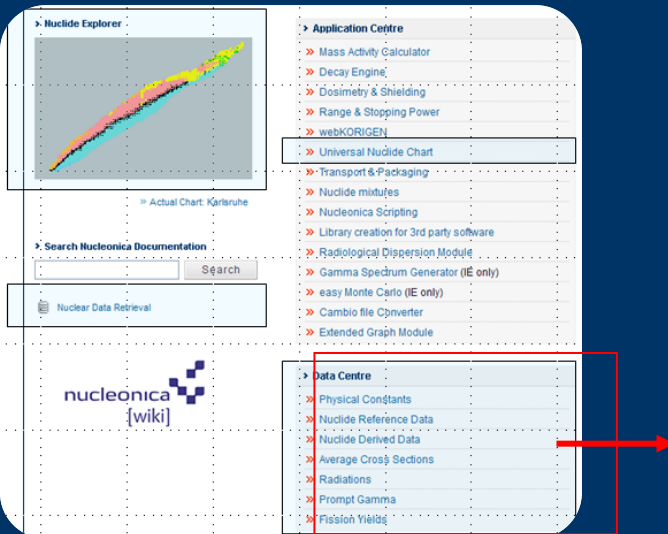
Cancel

What is a Nuclide Chart?



For light nuclei, $N = Z$, but with increasing Z , $N > Z$, i.e. the number of neutrons increases more strongly than the number of protons. Note that the stable isotopes lie within a relatively narrow range indicating that the neutron to proton ratio must have a certain value or range to be stable

Physical Constants...



The screenshot shows the Nucleonica web application. On the left, there's a 'Nuclide Explorer' with a chart. Below it is a 'Search Nucleonica Documentation' bar. At the bottom left is the 'nucleonica {wiki}' logo. On the right, there's an 'Application Centre' with various tools like 'Mass Activity Calculator', 'Decay Engine', etc. Below that is a 'Data Centre' menu. A red box highlights the 'Data Centre' menu, and a red arrow points from it to the 'Physical Constants' page.



Physical Constants

Physical Constants

Conversion Factors

Prefixes / Greek Alphabet

Radiological Limits

Physical Constants

Create new constant

Quantity	Symbol	Numerical Value	Uncertainty	Unit	Name In Script	
Speed of light in vacuum	c	299792458	0	ms ⁻¹	Const_c	Edit
Newtonian constant of gravitation	G	6.67428E-11	67	m ³ kg ⁻¹ s ⁻²	Const_G	Edit
Magnetic constant	μ_0	1.2566370614E-06	0	N/A ²	Const_mu0	Edit
Electric constant	ϵ_0	8.854187817E-12	0	Fm ⁻¹	Const_eps0	Edit
Planck constant	h	6.62606896E-34	33	Js	Const_planck	Edit
reduced Planck constant	\hbar	1.054571628E-34	53	Js	Const_planck_2pi	Edit
Atomic mass constant	u	1.660538782E-27	83	kg	Const_u	Edit
Energy equivalent of atomic mass constant	u	931.494028	23	MeV	Const_u_energy	Edit
Neutron mass	m_n	1.674927211E-27	84	kg	Const_mn	Edit

DataSheets...

Nuclide Explorer

Actual Chart: Karlsruhe

Application Centre

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Search Nucleonica Documentation

Nuclear Data Retrieval

nucleonica [wiki]

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Co60

10.47 m 5.27 y

Nuclide Datasheets

27 Cobalt

Current Chart: Karlsruhe

Element: Co Mass: 60

Reference Data Description Derived Data Cross Sections Radiations Prompt Gammas Select Print Outputs

» Reference Data Notes

Density	8.86 g/cm ³		
Mass Excess	-61649.012 (± 628) keV		
Atomic Mass	59.933817059 (± 674) u		
Half-life	5.271 (± 1) y		
Spin	5 ħ		
Parity	+		
Binding Energy	8.74675 MeV/nucleon		
Abundance	-		
Effective Dose Coefficient Inhalation	3.1E-08 (Sv/Bq)		
Effective Dose Coefficient Ingestion	3.4E-09 (Sv/Bq)		
Mean Decay Energies			
Alpha	0 (MeV)		
Electron	96.7734 (keV)		
Photon	2503.84 (keV)		
Type of decay	Branching Ratio	Decay Energy, Q	Daughters
β-	1	2.8239 (MeV)	28 Ni 60
Type of parent decay	Branching Ratio	Decay Energy, Q	Parents
IT	0.9975	0.0586 (MeV)	27 Co 60m

Download ☒ Excel ☐ CSV Separator: Semicolon (;) ☒ Use field qualifier (")

Fission Yields...

Pu239
2.4E4 y

Fission Yields

94 Plutonium

Current Chart: Karlsruhe

Element: Mass:

Pu

239

Select Fission Yields

Library:

JEFF-3.1

 Type of fission:

Thermal fission

Fission Yields Settings

Element Mass Number

Cs

Min Half-life

Seconds

Max Half-life

Seconds

☒ Enable advanced comparison

Results

Reset

Pu239
2.4E4 y

Fission Yields

94 Plutonium

Current Chart: Karlsruhe

Element: Mass:

Pu

239

Select Fission Yields

Library: JEFF-3.1
Type of Fission: Thermal fission
Total number of fission products: 25

	Nuclide	Half-life	Independent Yield	Error	Cumulative Yield	Error
Compare	55 Cs 135	2.3 (\pm 3) My	8.54E-05	3.04E-05	7.38E-02	2.36E-03
Compare	55 Cs 133	Stable	2.26E-07	8.21E-08	6.99E-02	1.26E-03
Compare	55 Cs 137	30.04 (\pm 3) y	4.57E-03	1.62E-03	6.59E-02	8.03E-04
Compare	55 Cs 138	33.41 (\pm 18) m	4.27E-03	1.44E-03	5.94E-02	1.61E-03
Compare	55 Cs 139	9.27 (\pm 5) m	2.30E-02	5.12E-03	5.72E-02	9.18E-04
Compare	55 Cs 140	1.062 (\pm 5) m	2.77E-02	4.64E-03	4.45E-02	1.12E-03
Compare	55 Cs 141	24.94 (\pm 6) s	2.92E-02	4.50E-03	3.38E-02	1.73E-03
Compare	55 Cs 142	1.70 (\pm 2) s	1.52E-02	3.67E-03	1.63E-02	2.48E-03
Compare	55 Cs 143	1.791 (\pm 7) s	5.95E-03	1.87E-03	6.06E-03	1.61E-03
Compare	55 Cs 138m	2.91 (\pm 8) m	6.06E-03	2.04E-03	6.06E-03	1.85E-03
Compare	55 Cs 144	994 (\pm 4) ms	5.69E-04	2.02E-04	8.62E-04	2.21E-04
Compare	55 Cs 136	13.03 (\pm 7) d	5.88E-04	2.07E-04	7.60E-04	2.15E-04
Compare	55 Cs 144m	1.0 (\pm 0) s	5.69E-04	2.02E-04	5.69E-04	1.99E-04
Compare	55 Cs 136m	19 (\pm 2) s	3.45E-04	1.21E-04	3.45E-04	1.21E-04
Compare	55 Cs 145	594 (\pm 13) ms	1.81E-04	6.42E-05	1.81E-04	6.38E-05
Compare	55 Cs 135m	53 (\pm 2) m	5.22E-05	1.86E-05	5.22E-05	1.86E-05

Nuclear Data Retrieval...

Nuclide Explorer



Actual Chart: Karlsruhe

Search Nucleonica Documentation


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Nuclear Data Retrieval

Nucleonica/JEFF-3.1

EGAF Prompt Gammas

ICRP

8th Table of Isotopes

Select Database:

Nucleonica

Nuclide Search

Radiation Search

Advanced Search

Nuclide Search – Search Variables & Range

Z:

Element:

Co

Mass Number: -

Stable/Primordial

Half-life

Isomers

Decay Mode

1

Weeks

-

100

Years

Table print options

☒ Decay mode

☒ Half-life

☐ Abundance

☐ Spin

☐ Parity

☐ Daughter Product

☒ Branching Ratio

☐ Q-Value

Search

Save to my defaults

Reset

Search returned 4 results

Number of nuclides: 4

Nuclides	Decay mode	Half-life	Branching Ratio
27 Co 56	ec/β+	77.31 (± 19) d	1
27 Co 57	ec	271.80 (± 5) d	1
27 Co 58	ec/β+	70.86 (± 7) d	1
27 Co 60	β-	5.271 (± 1) y	1

Download


Excel

CSV

Separator:

Semicolon (",")

☒ Use field qualifier (")



Nuclear Data Retrieval...



Nucleonica/JEFF-3.1

EGAF Prompt Gammas

ICRP

8th Table of Isotopes

Select Database: Nucleonica

Nuclide Search

Radiation Search

Advanced Search

Radiation Search – Search Variables & Range

☒ Gamma and X-Rays

Energy:

100

+/-

1

keV

☐ Alpha

200

+/-

1

keV

300

+/-

1

keV

Z:

Element:

Nd

Mass number:

-

Half-life:

Seconds

-

Seconds

-

Search

Save to my defaults

Reset

Search returned 6 results

Number of nuclides (ground + isomeric states): 2

Nuclides	Gamma and X-Rays (keV)	Emission Probability	Half-life
60 Nd 132	299	0.010584	1.47 (± 11) m
60 Nd 132	199.1	0.005292	1.47 (± 11) m
60 Nd 132	99.1	0.009408	1.47 (± 11) m
60 Nd 151	300.58	0.018221	12.44 (± 7) m
60 Nd 151	199.68	0.00266	12.44 (± 7) m
60 Nd 151	100.1	0.0003458	12.44 (± 7) m

Download

☒ Excel

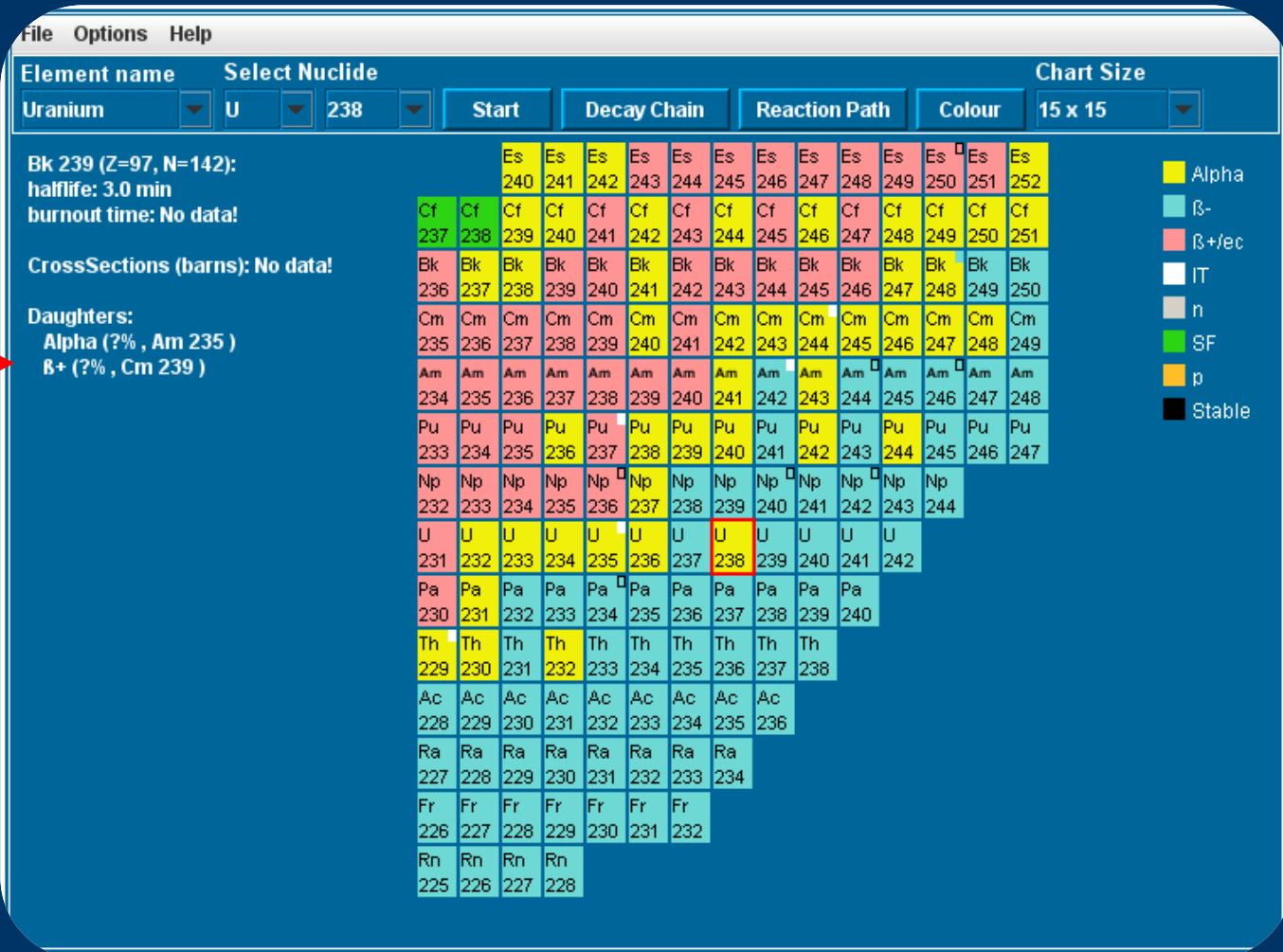
☐ CSV

Separator:

Semicolon (;)

☒ Use field qualifier ("")

Universal Nuclide Chart...

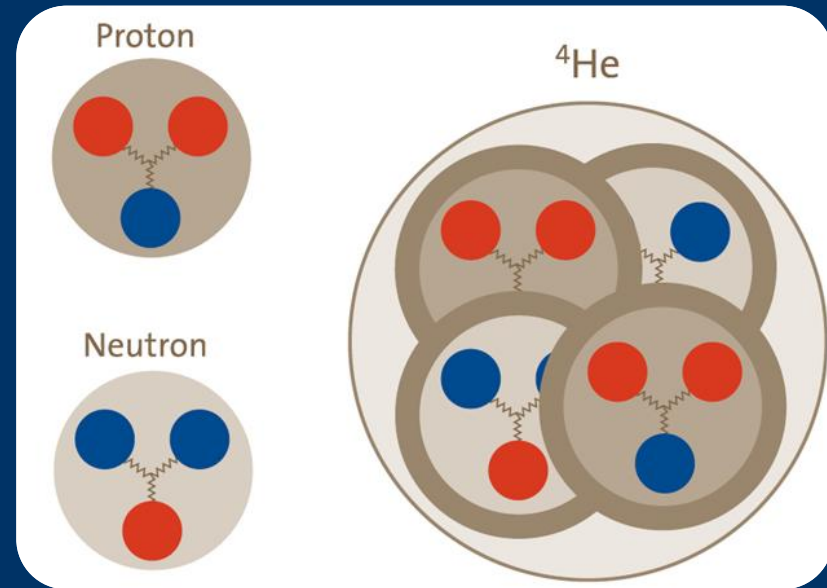


It all started with the Karlsruhe Nuclide Chart...



The Quark Structure of Nuclei

Quarks were proposed independently by Gell-Mann and Zweig in 1964 as the basic building blocks of matter. The word "quark" was coined by Gell-Mann based on the sound made by ducks. Later, he discovered the use of the word quark in James Joyce's book *Finnegan's Wake*.



The quark structure of nucleons: the proton consists of two up quarks (red) and one down quark (blue) and the neutron one up and two down quarks held together by powerful gluon fields. (Right) the overlap of protons and neutrons in a helium-4 nucleus based on the static sizes of particles © American Physical Society, 2003.

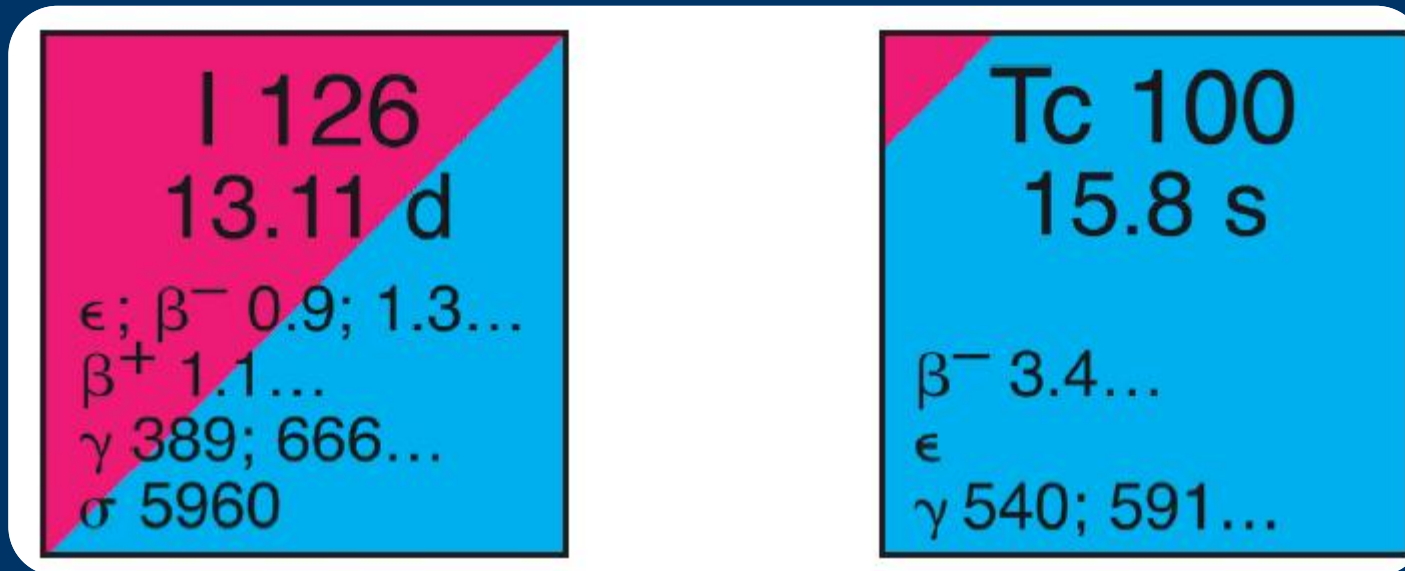
Use of colours in the Karlsruhe Nuclide Chart:

Already in the first Edition of the Karlsruhe Chart of the Nuclides, colours were used to indicate the decay modes

black = stable nuclide;
yellow = α -decay;
red = β^+ decay or electron capture;
blue = β^- decay;
white = isomeric transition).

Bi 207 31.55 a ϵ β^+ ... γ 570; 1064; 1770...	Bi 208 $3.68 \cdot 10^5$ a ϵ γ 2615	Bi 209 100 $1.9 \cdot 10^{19}$ a α 3.137 σ 0.011 + 0.023 $\sigma_{n,\alpha} < 3E-7$
Pb 206 24.1 σ 0.027	Pb 207 22.1 σ 0.61	Pb 208 52.4 σ 0.00023 $\sigma_{n,\alpha} < 8E-6$
Tl 205 70.48 σ 0.11	Tl 206 3.7 m γ 686; 453; 216; 256; 1021... β^- 1.5... γ (803...)	Tl 207 1.33 s γ 1000; 351 β^- 1.4... γ (898...)

Branching ratios...



When a nuclide has more than one decay mode, coloured triangles give a rough indication of the branching ratios of each mode.

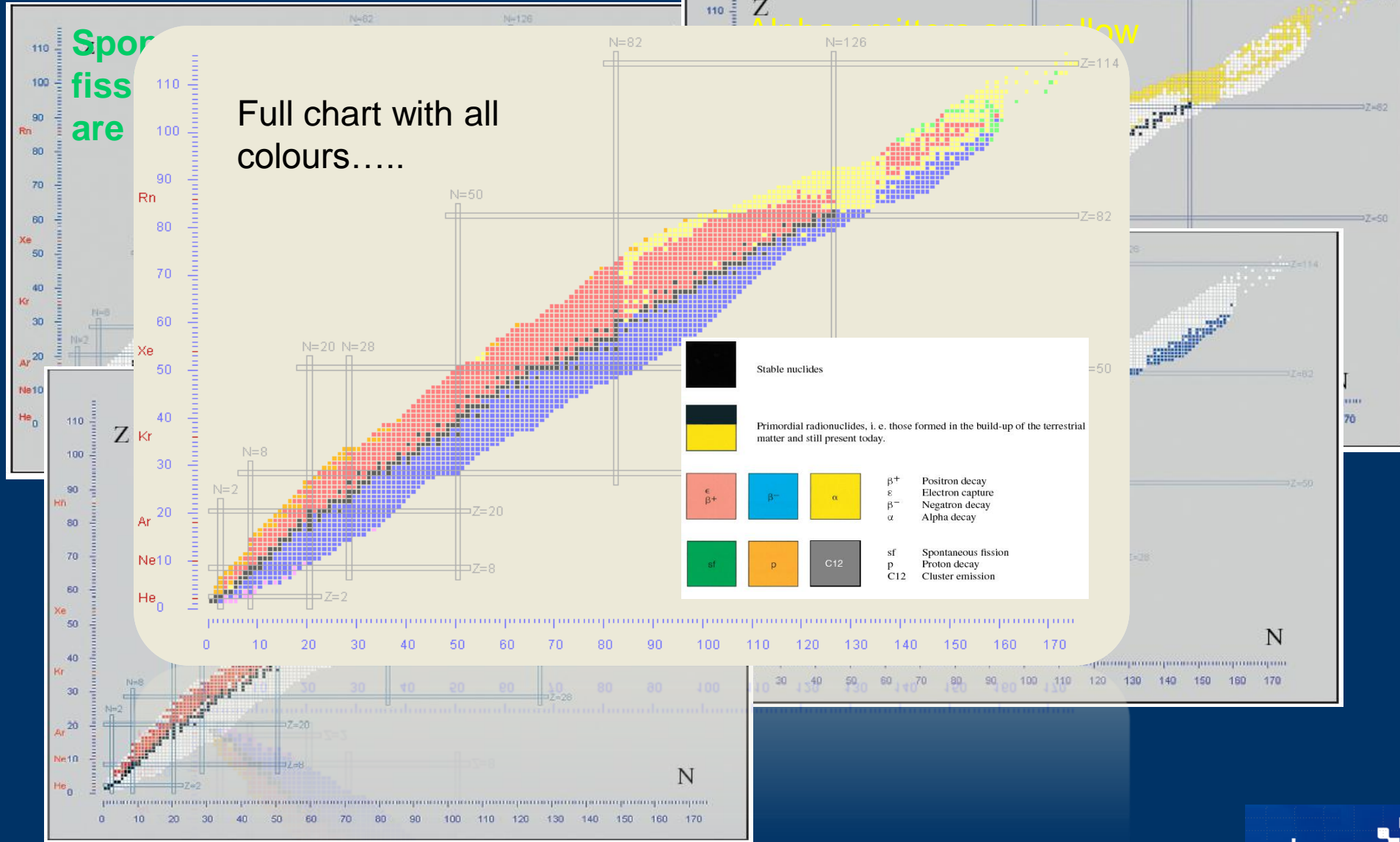
Left: The large triangles used in I-126, indicate the branching ratios for electron capture ϵ and β^- emission are $\geq 5\%$, but $\leq 95\%$ respectively.

Note that the decay modes are listed in the order of decreasing frequency.

Right: The small triangle used in Tc-100 indicates that the ϵ branching ratio is $\leq 5\%$. The corresponding branching ratio for β^- emission $\geq 95\%$.

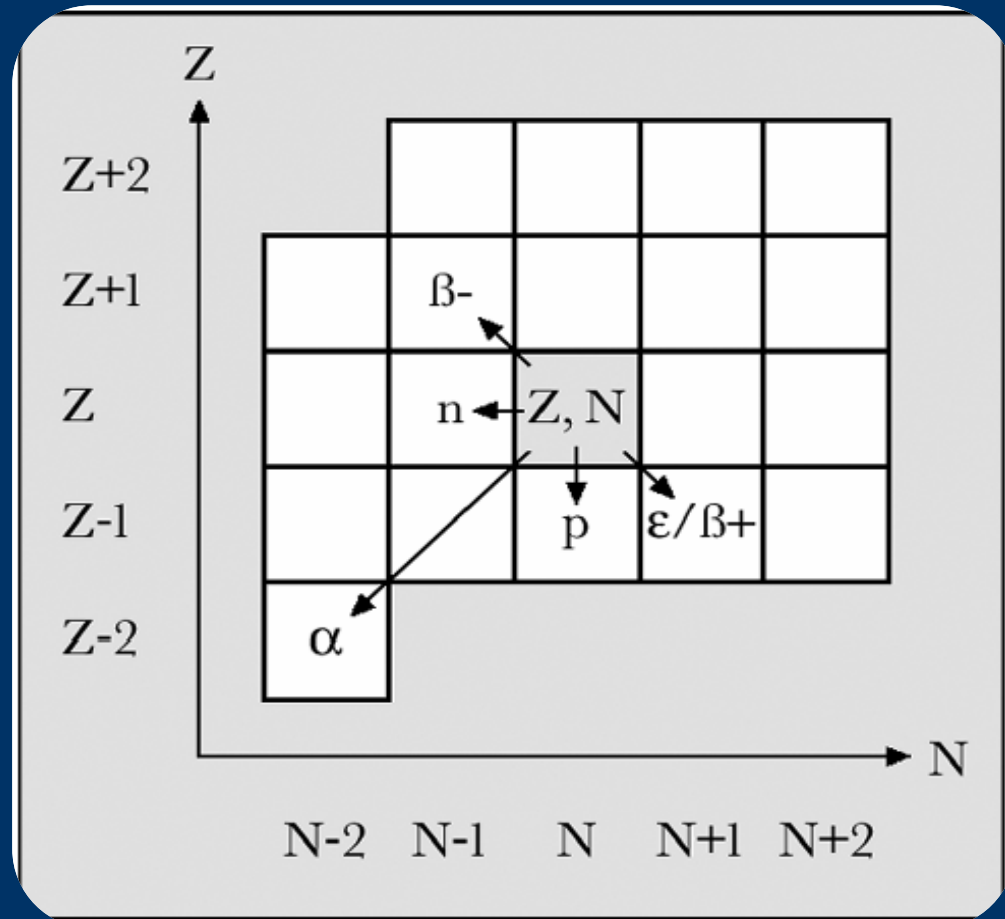
7			N 14.0067 $\sigma_{abs} 2.00$	N 10 2.3 MeV $200 \cdot 10^{-24}$ s p ?	N 11 ~0.77 MeV ? $\sim 590 \cdot 10^{-24}$ s ? p	N 12 11.0 ms $\beta^+ 16.4$ $\gamma 4439$ $\beta\alpha 0.2$	N 13 9.96 m $\beta^+ 1.2$ no γ	N 14 99.636 $\sigma 0.080$ $\sigma_n, p 1.93$	N 15 0.364 $\sigma 0.00004$		
6			C 12.0107 $\sigma 0.0035$	C 8 230 keV $2.0 \cdot 10^{-21}$ s 2p	C 9 126.5 ms $\beta^+ 15.5$ $\beta\alpha 8.24; 10.92$ Bn	C 10 19.3 s $\beta^+ 1.9$ $\gamma 718; 1022$	C 11 20.38 m $\beta^+ 1.0$ no γ	C 12 98.93 $\sigma 0.0035$	C 13 1.07 $\sigma 0.0014$	C 14 5730 a $\beta^+ 0.2$ no γ	
5			B 10.811 $\sigma_{abs} 760$	B 7 1.4 MeV $350 \cdot 10^{-24}$ s p	B 8 770 ms $\beta^+ 14.1$ $\beta\alpha 1.6; 8.3$	B 9 0.54 keV $800 \cdot 10^{-21}$ s p	B 10 19.9 $\sigma 0.3$ $\sigma_n, \alpha 3840$ $\sigma_n, p 0.007$	B 11 80.1 $\sigma 0.005$	B 12 20.20 ms $\beta^+ 13.4$ $\gamma 4439$ $\beta\alpha 0.2$	B 13 17.33 ms $\beta^+ 13.4$ $\gamma 3684$ $\beta n 3.6; 2.4$	
4			Be 9.012182 $\sigma 0.0088$	Be 6 92 keV $5 \cdot 10^{-21}$ s 2p	Be 7 53.29 d $\beta^+ 478$ $\beta\alpha 3.9000$	Be 8 6.8 eV $67 \cdot 10^{-18}$ s $\alpha 0.046$	Be 9 100 $\sigma 0.0088$	Be 10 $1.6 \cdot 10^6$ a $\beta^+ 0.6$ no γ $\sigma < 0.001$	Be 11 13.8 s $\beta^+ 11.5$ $\gamma 2125; 6791$ $\beta\alpha 0.77$	Be 12 23.6 ms $\beta^+ 11.7$ Bn	
3			Li 6.941 $\sigma_{abs} 71$	Li 4 5.0 MeV $91 \cdot 10^{-24}$ s p	Li 5 1.23 MeV $370 \cdot 10^{-24}$ s p	Li 6 7.59 $\sigma 0.039$ $\sigma_n, \alpha 940$	Li 7 92.41 $\sigma 0.045$	Li 8 840.3 ms $\beta^+ 12.5$ $\beta\alpha 1.6$	Li 9 178.3 ms $\beta^+ 13.6$ Bn 0.7 $\beta\alpha$	Li 10 230 keV $2.0 \cdot 10^{-21}$ s n	Li 11 8.5 ms $\beta^+ 18.5; 20.4$ $\gamma 3369; 320$ Bn, $\beta 2n, \beta 3n$ $\beta\alpha, \beta 1, \beta d$
2			He 4.002602 $\sigma_{abs} < 0.05$	He 3 0.000134 $\sigma 0.00005$ $\sigma_n, p 5330$	He 4 99.999866	He 5 648 keV $700 \cdot 10^{-24}$ s n	He 6 806.7 ms $\beta^+ 3.5$ Bd	He 7 159 keV $2.9 \cdot 10^{-21}$ s n	He 8 119 ms $\beta^+ 9.7$ $\gamma 981; 4781$ Bn, $\beta 1$	He 9 65 keV $7 \cdot 10^{-21}$ s n	He 10 0.17 MeV $2.7 \cdot 10^{-21}$ s 2n
1			H 1.00794 $\sigma 0.332$	H 1 99.9885 $\sigma 0.332$	H 2 0.0115 $\sigma 0.00051$	H 3 12.323 a $\beta^+ 0.02$ $\sigma < 0.000008$	H 4 3.28 MeV $139 \cdot 10^{-24}$ s n	H 5 1.9 MeV ? $240 \cdot 10^{-24}$ s ? 2n	H 6 1.6 MeV $290 \cdot 10^{-24}$ s n ? 3n ?	H 7 20 MeV $23 \cdot 10^{-24}$ s 2n ?	8 0.73E-4 0.69E-4 0.41E-4 0.11E-3
			n 1 10.25 m $\beta^+ 0.8$	8.40E-4 1.35E-3	0.01080 0.01420	0.1700 0.2190	2.67E-3 4.10E-3	1.4E-4	1.71E-3 4.08E-3		
						4	6				

What the colours mean...



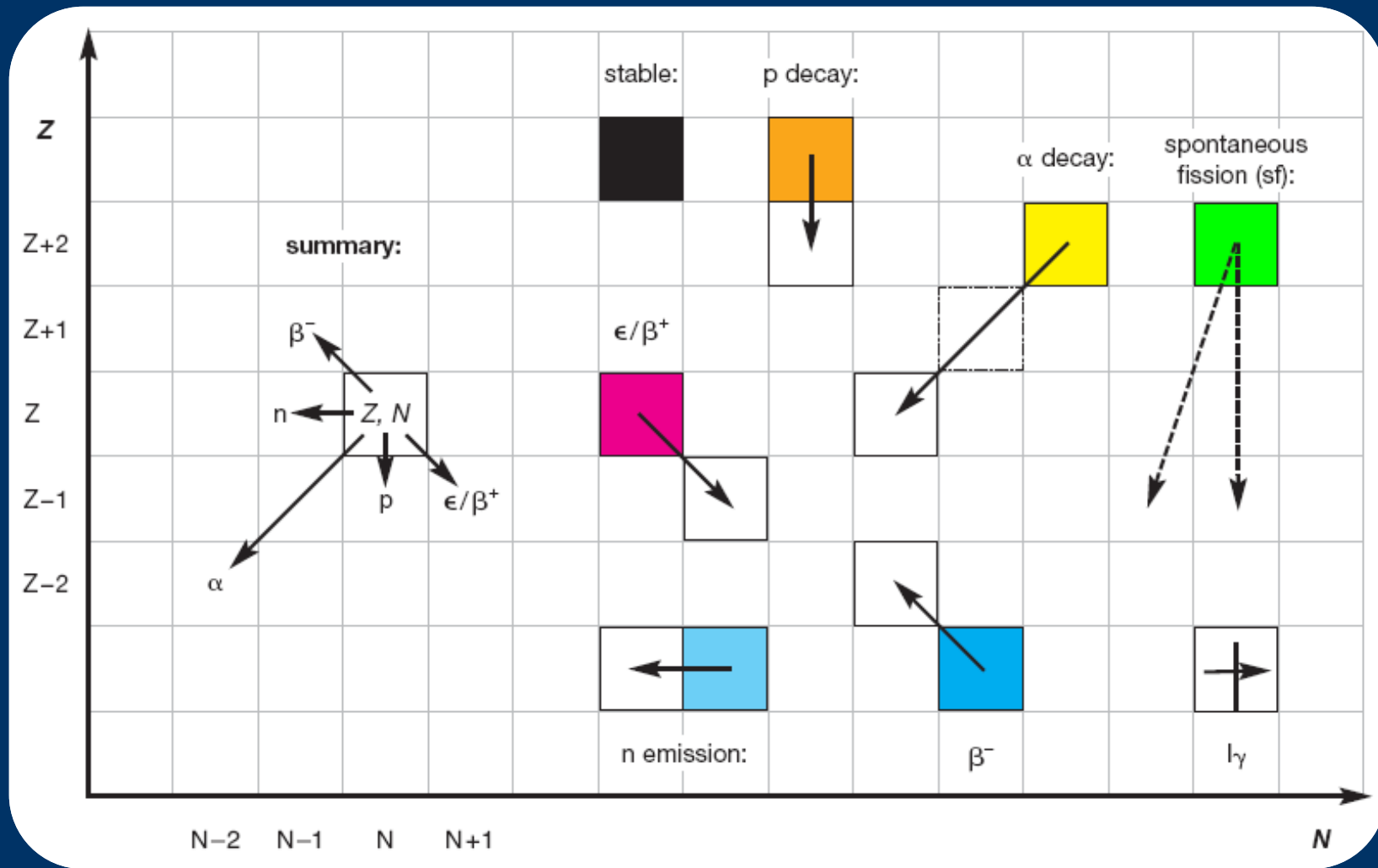
Radioactive Decay Processes

Nuclear decay processes on the nuclide chart. A nuclide with “co-ordinates” Z, N transforms to the nuclide Z', N' through the decay processes shown

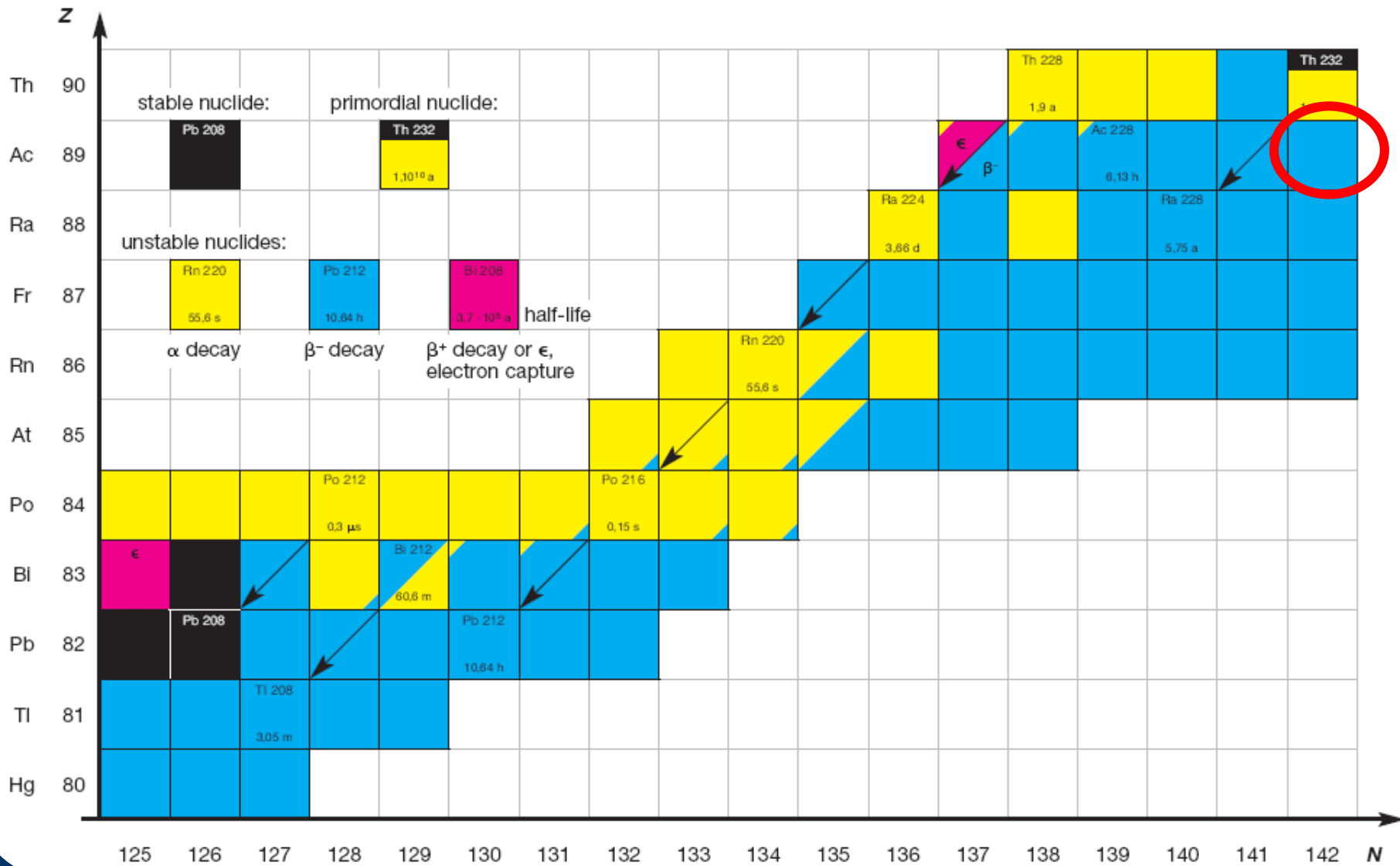


$N-2$ $N-1$ N $N+1$ $N+2$

Radioactive Decay on the Nuclide Chart...



Karlsruher Nuklidkarte: Th232 decay chain



Thanks!

